5.4.11 DROUGHT

This section provides a profile and vulnerability assessment for the drought hazard.

HAZARD PROFILE

This section provides profile information including: description, location and extent, previous occurrences and losses, and the probability of future occurrences.

Description

The National Weather Service (NWS) Climate Prediction Center (CPC) defines drought as a deficiency of moisture that results in adverse impacts on people, animals, or vegetation over a sizeable area. According to the NYS HMP, drought is a normal, recurrent feature of climate. It occurs almost everywhere, although its features vary from region to region. Defining drought is therefore difficult; it depends on differences of regions, water supply needs, and disciplinary perspectives. In general, drought originates from a deficiency of precipitation over an extended period of time, resulting in a water shortage for some activity, group, or environmental sector (NYSEMO, 2004). Other climatic factors, such as high temperatures, prolonged high winds and low relative humidity, can aggravate the severity of a drought. These conditions are caused by anomalous weather patterns when shifts in the jet stream block storm systems from reaching an area. As a result, large high-pressure cells may dominate a region for a prolonged period, thus reducing precipitation.

This natural hazard differs from other hazards in several ways. First, there is no universally accepted definition of drought. Second, drought onset and recovery are usually slow. Third, droughts can impact a much larger area and last many times longer than most other natural hazards. Fourth, droughts historically have occurred as are part of the natural variability of weather patterns. Due to these differences, many communities have neglected to include this hazard in their disaster management plans (ICLR, 2005).

According to FEMA and the NWS, there are four different ways that drought can be defined or grouped:

- Meteorological - a measure of departure of precipitation from normal. It is defined solely on the degree of dryness. Due to climatic differences, what might be considered a drought in one location of the country may not be a drought in another location.
- Agricultural - refers to a situation where the amount of moisture in the soil no longer meets the needs of a particular crop. It is defined in terms of soil moisture deficiencies relative to water demands of plant life, primarily crops.
- Hydrological - occurs when surface and subsurface water supplies are below normal. It is related to the effects of precipitation shortfalls on streamflows and reservoir, lake and groundwater levels.
- Socioeconomic - refers to the situation that occurs when physical water shortages begin to affect people. It associates the supply and demand of economic goods or services with elements of meteorologic, hydrologic and agricultural drought. This drought type occurs when the demand for water exceeds the supply as a result of a weather related supply shortfall (NWS, Date Unknown).

According to the NYS HMP, drought produces an array of impacts that span many sectors of the economy and reach beyond the areas that experience the physical drought. This complexity exists because water is integral to our ability to produce goods and provide services. Direct impacts of drought (e.g., reduced crops, increased fire hazards, reduced water levels, damage to wildlife and fish habitat) have cascading indirect impacts (e.g., reduced income from a lack of crop production, increased prices due to a crop shortage, unemployment). The many impacts of drought can be listed as economic, environmental, or social. Economic impacts occur in agriculture and related sectors because of the reliance of these sectors on surface and subsurface water supplies. Environmental impacts are the result of damage to plant and animal species, wildlife habitat, and air and water quality, forest and grass fires, degradation of landscape quality, loss of biodiversity and soil erosion. Social impacts involve public safety, health, conflicts between water users, reduced quality of life and inequities in the distribution of impacts and disaster relief. A summary of potential impacts associated with the drought hazard are identified in Table 5-60. This table includes only some of the potential impacts of drought.

Table 5-60. Economical, Environmental and Social Impacts of Drought

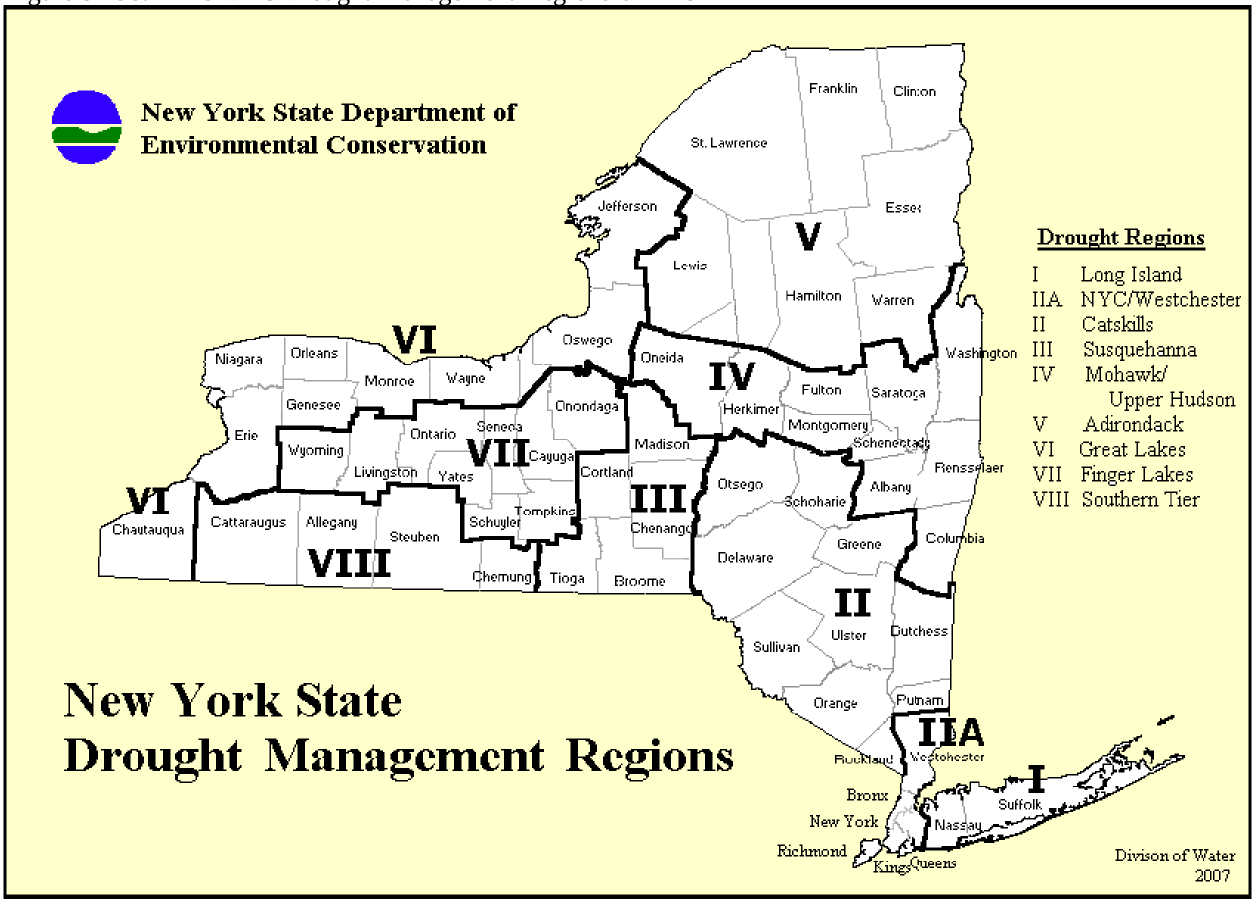
Economical	Environmental	Social
• Loss of national economic growth, slowing down of economic development • Damage to crop quality, less food production • Increase in food prices • Increased importation of food (higher costs) • Insect infestation • Plant disease • Loss from dairy and livestock production • Unavailability of water and feed for livestock which leads to high livestock mortality rates • Disruption of reproduction cycles (breeding delays or unfilled pregnancies) • Increased predation • Increased fire hazard - Range fires and Wildland fires • Damage to fish habitat, loss from fishery production • Income loss for farmers and others affected • Unemployment from production declines • Loss to recreational and tourism industry • Loss of hydroelectric power • Loss of navigability of rivers and canals	• Increased desertification - Damage to animal species • Reduction and degradation of fish and wildlife habitat • Lack of feed and drinking water • Disease • Increased vulnerability to predation. • Loss of wildlife in some areas and too many in others • Increased stress to endangered species • Damage to plant species, loss of biodiversity • Increased number and severity of fires • Wind and water erosion of soils • Loss of wetlands • Increased groundwater depletion • Water quality effects • Increased number and severity of fires • Air quality effects	• Food shortages • Loss of human life from food shortages, heat, suicides, violence • Mental and physical stress • Water user conflicts • Political conflicts • Social unrest • Public dissatisfaction with government regarding drought response • Inequity in the distribution of drought relief • Loss of cultural sites • Reduced quality of life which leads to changes in lifestyle • Increased poverty • Population migrations

Source: ThinkQuest, Date Unknown

Location and Extent

Long Island is identified as NYS Department of Environmental Conservation (NYS DEC) Drought Management Region 1 (Figure 5-198).

Figure 5-198. NYS DEC Drought Management Regions of NYS



Source: NYSDEC, 2007

All of SC is susceptible to drought. Areas at particular risk include communities that rely on private wells for potable water supply; certain areas with elderly, impoverished, or otherwise vulnerable populations; and agricultural resources which require the abundant use of ample water supply to thrive. All of Long Island-from Queens to Montauk depends upon its groundwater for its drinking water. Most of SC is serviced by the non-profit SC Water Authority (SCWA), which is the largest public water supplier on Long Island. The SCWA operates the largest water system in the nation based entirely upon groundwater. Serving over 300,000 accounts and 1.2 million consumers, SCWA pumps nearly 44 billion gallons of potable water each year. Groundwater is pumped from 400 active wells in 180 well fields strategically located across SC's 85-mile long, 10 mile-wide, 850-square mile area. On average, SC receives about 45 inches of rain per year with more than 900,000,000 gallons of water entering the aquifers on an average day. Even during the summer at peak usage, the SCWA rarely pumps out more than 400,000,000 gallons in a single day (SCWA, 2002).

Severe drought conditions could reduce groundwater recharge and decrease the water supply for residential and agricultural users. According to the South Fork Groundwater Task Force, the SCWA water use rate increases annually, as development and the demand for water increases. This trend will not reverse itself. With more and more development taking place year after year, the demand on groundwater will become even greater, which increases the risk of potential hardships during drought events. Consumption of groundwater coupled with drought can lead to a variety of related problems (e.g., impacts to the natural resources of SC, such as lowering ponds and streams and negatively effecting wetlands).

As indicated by Charles Groat of USGS in February 19, 2005, understanding water storage--both surface water and ground water storage--is critical in understanding the effects of climate variability. As surface-water storage becomes more limited, use of ground-water storage to modulate the effects of droughts increases in importance, as do potential enhancements by artificial recharge. If ground-water storage is large, droughts will have a small, if any, effect on long-term water storage in an aquifer system. In contrast, where ground-water storage has been substantially reduced by long-term withdrawals from wells, it may be more limited as a source of water to help cope with droughts, which may potentially be the case for SC. Fifty years of data were analyzed to show the effects of drought and changing water use and wastewater disposal on Long Island's ground-water system. Ground water from the upper glacial, Magothy, and Lloyd aquifers is used to supply water to nearly half of the 7.5million people on Long Island. Because of the long history of dependence on ground water, the USGS has collected hydrologic data on Long Island since the early 1900s. The network consists of over 600 wells throughout Long Island. These long-term hydrologic data show significant declining changes in water levels over the past 100 years. These changes are due to the changing history of water use in New York City and areas east, sewering, increased pumping and climate variation. Water-level declines from 1963 to 1967 are due to effects of the regional drought in the 1960s. In this urbanized area, ground-water withdrawal and urbanization mask water-level fluctuations associated with precipitation. This demonstrates the many factors that affect hydrologic processes and water availability throughout Long Island (Groat, 2005).

SC is the largest agricultural county in NYS based on dollar value of product sales. SC has the largest and fastest growing wine industry in the US, ranked second only to California in United States grape production. SC also has the state's largest horticultural sales and service industry. Towns within SC that include significant farmland include Southampton, Southold, Brookhaven and Riverhead. Agricultural resources need ample amounts of water for successful production; which not only relies on natural precipitation but also requires the supply and demand of groundwater resources, both which become limited or compromised during times of drought.

According to FEMA, the extent (e.g., magnitude or severity) of drought can depend on the duration, intensity, geographic extent, and the regional water supply demands made by human activities and vegetation. The intensity of the impact from drought could be minor to total damage in a localized area or regional damage affecting human health and the economy. Generally, impacts of drought evolve gradually and regions of maximum intensity change with time. The severity of a drought is determined by areal extent as well as intensity and duration. The frequency of a drought is determined by analyzing the intensity for a given duration, which allows determination of the probability or percent chance of a more severe event occurring in a given mean return period.

Drought is a recurring natural phenomenon characterized by its severity, duration and extent. It is therefore a three-dimensional phenomenon, which is difficult to assess. The wide variety of resources affected by drought, its diverse geographical and temporal distribution, and the many scales drought operates on make it difficult to develop either a definition to describe drought or an index to measure it. Many quantitative measures of drought have been developed in the United States, depending on the discipline affected, the region being considered, and the particular application. Several indices developed by Wayne Palmer [Palmer Drought Severity Index (PSDI) and Crop Moisture Index (CMI)], as well as the Standardized Precipitation Index (SPI), are useful for describing the many scales of drought. Other indices include accumulated departure from normal streamflows, low-flow frequency estimates and changes in water storage, groundwater levels and rates of decline, and lake levels. Some of the most commonly used indices to measure or identify the severity and classification of past and present droughts primarily includes, but not limited to, the following:

<u>NOAA-NCDC - Palmer Drought Severity Index (PDSI) / Crop Moisture Index (CMI)</u>: The PDSI developed in 1965, indicates the prolonged and abnormal moisture deficiency or excess. The CMI gives

the short-term or current status of purely agricultural drought or moisture surplus and can change rapidly from week to week. The PDSI is an important climatological tool for evaluating the scope, severity, and frequency of prolonged periods of abnormally dry or wet weather. It can be used to help delineate disaster areas and indicate the availability of irrigation water supplies, reservoir levels, range conditions, amount of stock water, and potential intensity of forest fires. The CMI, developed in 1968, can be used to measure the status of dryness or wetness affecting warm season crops and field activities (NWS, 2005).

The PDSI was developed by Wayne Palmer in the 1960s and uses temperature and rainfall information in a formula to determine dryness. It has become the semi-official drought index. The PDSI is most effective in determining long term drought - a matter of several months - and is not as good with short-term forecasts (a matter of weeks). It uses a 0 as normal, and drought is shown in terms of minus numbers; for example, minus 2 is moderate drought, minus 3 is severe drought, and minus 4 is extreme drought. The PDSI can also reflect excess rain using a corresponding level reflected by plus figures; i.e., 0 is normal, plus 2 is moderate rainfall, etc. (Table 5-61). The advantage of the PDSI is that it is standardized to local climate, so it can be applied to any part of the country to demonstrate relative drought or rainfall conditions. The negative is that it is not as good for short term forecasts, and is not particularly useful in calculating supplies of water retained in snow, so it works best east of the Continental Divide. The CMI is a formula that was also developed by Wayne Palmer subsequent to his development of the PDSI. The CMI responds more rapidly than the PDSI and can change considerably from week to week, so it is more effective in calculating short-term abnormal dryness or wetness affecting agriculture. CMI is designed to indicate normal conditions at the beginning and end of the growing season; it uses the same levels as the PDSI (NOAA, Date Unknown).

Table 5-61. PSDI Classifications

Palmer Classifications	
4.0 or more	extremely wet
3.0 to 3.99	very wet
2.0 to 2.99	moderately wet
1.0 to 1.99	slightly wet
0.5 to 0.99	incipient wet spell
0.49 to -0.49	near normal
-0.5 to -0.99	incipient dry spell
-1.0 to -1.99	mild drought
-2.0 to -2.99	moderate drought
-3.0 to -3.99	severe drought
-4.0 or less	extreme drought

Source: Hayes, 2006

<u>NOAA-NCDC U.S. Standardized Precipitation Index (SPI)</u>: While Palmer's indices are water balance indices [considering water supply (precipitation), demand (evapotranspiration) and loss (runoff)], the SPI is a probability index that considers only precipitation. The SPI is based on the probability of recording a given amount of precipitation, probabilities are standardized so that an index of zero indicates the median precipitation amount (half of the historical precipitation amounts are below the median, and half are above the median). The index is negative for drought and positive for wet conditions. As the dry or wet conditions become more severe, the index becomes more negative or positive. The SPI is computed by NCDC for several time scales, ranging from one month to 24 months, to capture the various scales of both short-term and long-term drought.

National Drought Mitigation Center (NDMC) (University of Nebraska / Lincoln) – U.S. Drought Monitor: The NDMC helps people and institutions develop and implement measures to reduce societal vulnerability to drought, stressing preparedness and risk management rather than crisis management. Most of the NDMC's services are directed to state, federal, regional, and tribal governments that are involved in drought and water supply planning. The NDMC produces a daily drought monitor map that identifies drought areas and ranks droughts by intensity. U.S. Drought Monitor summary maps are available from May 1999 through the present and identify general drought areas and classification droughts by intensity ranging from D1 (moderate drought) to D4 (exceptional drought). D0, drought watch areas, are drying out and possibly heading for drought, or are recovering from drought but not yet back to normal, suffering long-term impacts such as low reservoir levels (Table 5-62). The Drought Monitor is intended to provide a general and up-to-date summary of current drought conditions across the U.S., Puerto Rico, and U.S. Pacific territories. This monitor provides a "big picture" view for the general public, media, government officials, and others. To keep the map from becoming too complex, the drought categories shown represent typical drought intensities, not each drought intensity within an impacted area. The map is not designed to depict local conditions or to replace drought warnings and watches issued by local or regional government entities. Local or state entities may monitor different indicators than those used in the Drought Monitor to meet specific needs or to address local problems. As a consequence, there could be water shortages or crop failures within an area not designated as drought, just as there could be locations with adequate water supplies in an area designated as D3 or D4 (extreme or exceptional) drought.

The Drought Impact Reporter is an interactive tool developed by the NDMC to collect, quantify, and map reported drought impacts for the United States (and was used to identify known drought events throughout SC for this plan). The Drought Impact Reporter was created in response to the need for a national drought impact database. A risk management approach to drought management, which strongly emphasizes improved monitoring and preparedness, requires timely information on the severity and spatial extent of drought and its associated impacts. The information provided by the Drought Impact Reporter will help policy and decision makers identify what types of impacts are occurring and where (NDMC, Date Unknown).

NOAA-NCDC North American Drought Monitor: The North America Drought Monitor (NA-DM) is a cooperative effort between drought experts in Canada, Mexico and the United States to monitor drought across the continent. The Drought Monitor concept was developed jointly by the NWS, the NDMC, and the US Department of Agriculture's Joint Agricultural Weather Center in the late 1990s. This monitoring process synthesizes multiple indices, outlooks, and local impacts, into an assessment that best represents current drought conditions. The final outcome of each Drought Monitor is a consensus of federal, state and academic scientists. Maps of U.S. droughts are available from this source from 2003 to 2007 (NCDC, 2006).

As presented by the NDMC, drought intensity categories are based on six key indicators and numerous supplementary indicators. Table 5-62 shows the indicators considered and ranges for each indicator based on dryness levels. Because the ranges of the various indicators often do not coincide, the final drought category tends to be based on what the majority of the indicators show. The analysts producing the map also weight the indices according to how well they perform in various parts of the country and at different times of the year. Additional indicators are often used in the West, where winter snowfall has a strong bearing on water supplies.

Table 5-62. NDMC Drought Severity Classification Table

Category	Description	Possible Impacts	Palmer Drought Severity Index (PDSI)	CPC Soil Moisture Model (%)	USGS Weekly Streamflow (%)	Standardized Precipitation Index (SPI)	Satellite Vegetation Health Index
D0	Abnormally Dry	Going into drought: short-term dryness slowing planting, growth of crops or pastures; fire risk above average. Coming out of drought: some lingering water deficits; pastures or crops not fully recovered.	-1.0 to -1.9	21-30	21-30	-0.5 to -0.7	36-45
D1	Moderate Drought	Some damage to crops, pastures; fire risk high; streams, reservoirs, or wells low, some water shortages developing or imminent, voluntary water use restrictions requested	-2.0 to -2.9	11-20	11-20	-0.8 to -1.2	26-35
D2	Severe Drought	Crop or pasture losses likely; fire risk very high; water shortages common; water restrictions imposed	-3.0 to -3.9	6-10	6-10	-1.3 to -1.5	16-25
D3	Extreme Drought	Major crop/pasture losses; extreme fire danger; widespread water shortages or restrictions	-4.0 to -4.9	3-5	3-5	-1.6 to -1.9	6-15
D4	Exceptional Drought	Exceptional and widespread crop/pasture losses; exceptional fire risk; shortages of water in reservoirs, streams, and wells, creating water emergencies	-5.0 or less	0-2	0-2	-2.0 or less	1-5

Source: NDMC, 2003. Note: Additional indices used, mainly during the growing season, include the USDA/NASS Topsoil Moisture, Crop Moisture Index (CMI), and Keetch Byram Drought Index (KBDI). Indices used primarily during the snow season and in the West include the River Basin Snow Water Content, River Basin Average Precipitation, and the Surface Water Supply Index (SWSI).

Previous Occurrences and Losses

NYS is made up of 10 climate divisions, with SC located in the Coastal Climate Division (Division 4) (CCD). According to the NRCC, the NYS Coastal Climate Division has experienced numerous drought periods with a drought from 1965 to 1966 constituting the longest drought period on record. These drought periods are identified in Table 5-63.

Table 5-63. Drought Events between 1895 and 2006

Coastal Climate Division		
Drought Periods	**Duration**	**Lowest PDSI**
September 1910 – July 1911	11 months	-3.77 in 5/1911
March 1930 – February 1931	12 months	-3.81 in 9/1930
November 1931 – February 1932	4 months	-3.39 in 12/1931

Coastal Climate Division		
Drought Periods	**Duration**	**Lowest PDSI**
November 1949 – January 1950	3 months	-3.63 in 1/1950
September 1964 – December 1964	4 months	-3.88 in 11/1964
May 1965 – August 1966	16 months	-5.63 in 12/1965
March 1985 – April 1985	2 months	-3.65 in 4/1985
July 1999 – August 1999	2 months	-3.94 in 7/1999
January 2002 – May 2002	5 months	-4.22 in 2/2002

Source: NRCC, 2006
Note: Based on the monthly Palmer Drought Severity Index as computed by the National Climatic Data Center.
Period of record: January 1895 through March 2006

Additional sources document additional drought events within the SC area. Based on all sources researched, 22 notable drought periods have impacted SC as identified in Table 5-64. Information regarding specific losses or impacts associated with many identified drought events was limited or not reported in most cases but is included if such data was available in the sources reviewed.

Table 5-64. Drought Events between 1910 and 2005

Event Date / Name	Location	Losses / Impacts	Source(s)
September 1910 – July 1911	CCD	NA	NRCC-Cornell - Based on monthly PDSI by NCDC
1927 – 1932	L.I.	NA	Stacy Ann Lawrence and Gilbert Hanson - Dept. of Geosciences of State University of New York - "Dendrochronology and Geochemistry of Long Island Trees"
March 1930 – February 1931	CCD	NA	NRCC-Cornell - Based on monthly Palmer Drought Severity Index by NCDC
November 1931 – February 1932	CCD	NA	NRCC-Cornell - Based on monthly PDSI by NCDC
November 1949 – January 1950	CCD	NA	NRCC-Cornell - Based on monthly PDSU by NCDC
1962 - 1966	L.I.	changes in ground-water discharge to streams (baseflow) and declines in ground-water levels	USGS - "Simulation of the Effects of Development of the Groundwater Flow System of Long Island, New York"
September 1964 – December 1964	CCD	NA	NRCC-Cornell - Based on monthly PDSI by NCDC
May 1965 – August 1966	CCD	NA	NRCC-Cornell - Based on monthly PDSI by NCDC
1960 - 1970	L.I.	NA	Stacy Ann Lawrence and Gilbert Hanson - Dept. of Geosciences of State University of New York - "Dendrochronology and Geochemistry of Long Island Trees"
March 1985 – April 1985	CCD	NA	NRCC-Cornell - Based on monthly PDSI by NCDC

Event Date / Name	Location	Losses / Impacts	Source(s)
1980 - 1988	L.I.	NA	Stacy Ann Lawrence and Gilbert Hanson - Dept. of Geosciences of State University of New York - "Dendrochronology and Geochemistry of Long Island Trees"
August 1995 – September 1995	Southeastern NYS	6,850 acres of forest lost from wildfire during the drought, 49 injuries	NOAA CPC- Special Climate Summary (9/1/95), NY Times.com "Fire on Long Island-City Weighing Rules on Water"
July 1999 – August 1999	NYS	Water restrictions, danger of wildfire, declared agricultural disaster areas.	Jim Morris - CNN.com - "U.S. Drought Worsens - Northeast, MidAtlantic Hardest Hit" - Jul. 28, 1999; NRCC-Cornell - Based on monthly PDSI by NCDC
2001 - 2002	Multi- County (including SC)	NA	James Farr - "Patchogue Lake, Long Island, NY - One Year after Drought of 2002" ; Cornell News Release
2002 crop season	Multi- County (including SC)	NA	NYS Dept. of Agriculture and Markets News (Nov. 19-22, 2002) by Jessica Chittenden; NOAA-NCDC "September New York Drought"
January 2002 – May 2002	CCD	NA	NRCC-Cornell - Based on monthly PDSI by NCDC
February 26, 2002	Multi- County (including SC)	NA	North Country Trail - "Drought Watch in Pennsylvania and New York".
March 12, 2002	Multi- County (including SC)	NA	U.S. Drought Monitor
May 7, 2002	Multi- County (including SC)	NA	U.S. Drought Monitor
September 2003	Patchogue Lake, L.I.	NA	James Farr - "Patchogue Lake, Long Island, NY - One Year after Drought of 2002"
May 1, 2005 and continuing	Multi- County (including SC)	NA	SBA Declaration #10329
July 2005 – August 2005	Multi- County (including SC)	NA	SC Government - (http://www.co.suffolk.ny.us/pressreleases.cfm?ID=1408&dept=19) - Aug. 22, 2005

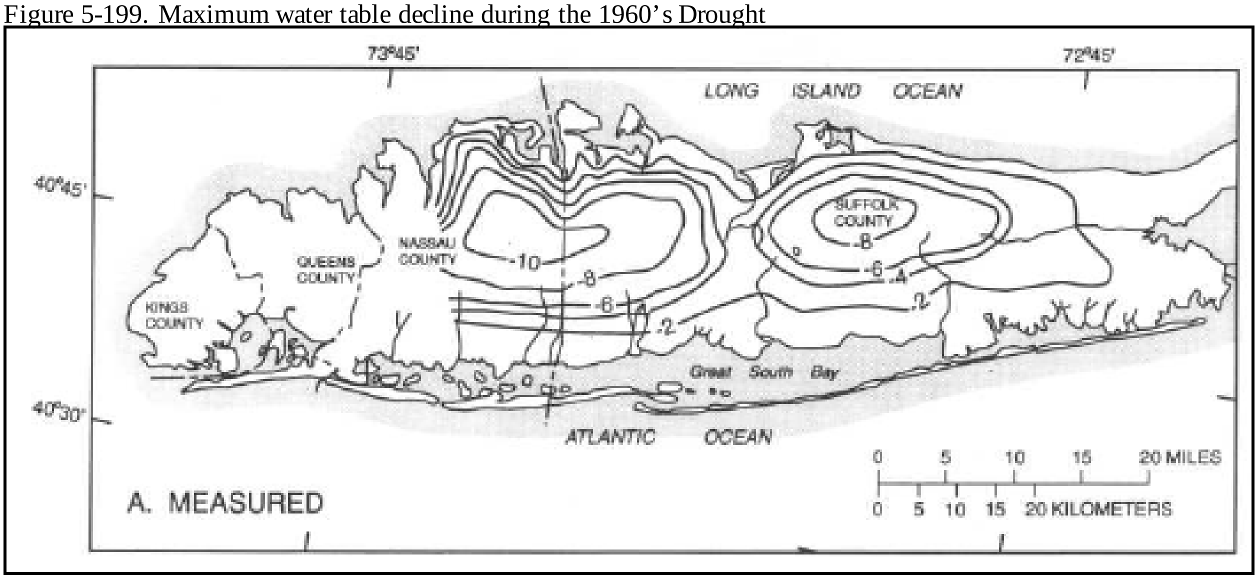
CD Climate Coastal Division
CPC Climate Prediction Center
DR Federal Disaster Declaration
EM Federal Emergency Declaration
FEMA Federal Emergency Management Agency
FSA Farm Service Agency
HMP Hazard Mitigation Plan
K Thousand ($)
LI Long Island
M Million ($)
NA Not Available
NOAA-NCDC National Oceanic Atmospheric Administration – National Climate Data Center
NRCC Northeast Regional Climate Center
NWS National Weather Service
NYS New York State
SBA Small Business Association
SC Suffolk County
USDA U.S. Department of Agriculture
USGS U.S. Geological Survey

Details regarding significant drought periods that have impacted SC include, but are not limited to, the following:

1962 through 1966 (4 year period): According to U.S. Geological Survey, Water-Resources Investigations Report 98-4069 "Simulation of the Effects of Development of the Groundwater Flow System of Long Island, New York," Long Island experienced a prolonged drought during this period. The decrease in surface and groundwater recharge from precipitation over this period caused many streams to reach their lowest recorded flows and ground water levels to decline by as much as 10 feet below the norm. The main stress on the groundwater system associated with the drought was the loss of recharge through the natural decrease in precipitation. The major hydrologic responses to the 1960's drought were changes in ground-water discharge to streams (baseflow) and declines in ground-water levels. The analysis focused on eastern Nassau and Suffolk Counties because water levels in western Long Island were being affected by development at this time. Base flow decreased noticeably in 1963 and, in most streams, had a maximum decrease of 25 to 60 percent. Streams with long channels that extend far inland (e.g., Nissequogue, Carlls, Connetquot Creeks,and Peconic River) showed the greatest seasonal variation and the greatest percent decrease in base flow during the drought because their headwaters lie close to the ground-water divide, where water-table declines are greatest. Stream headwaters are most vulnerable to large fluctuations in base flow and to drying up.

Water level declines began in 1963 and accelerated in 1964 and 1965, when little water-level recovery occurred during the wet season. The largest total water table decline occurred at locations farthest from the shore and streams; drawdown near streams is typically subdued because streams provide a source of water. The maximum decline exceeded 10 feet near the Nassau-Suffolk County Border and 8 feet in central SC (Buxten and Smolensky, 2005).

Figure 5-199. Maximum water table decline during the 1960's Drought



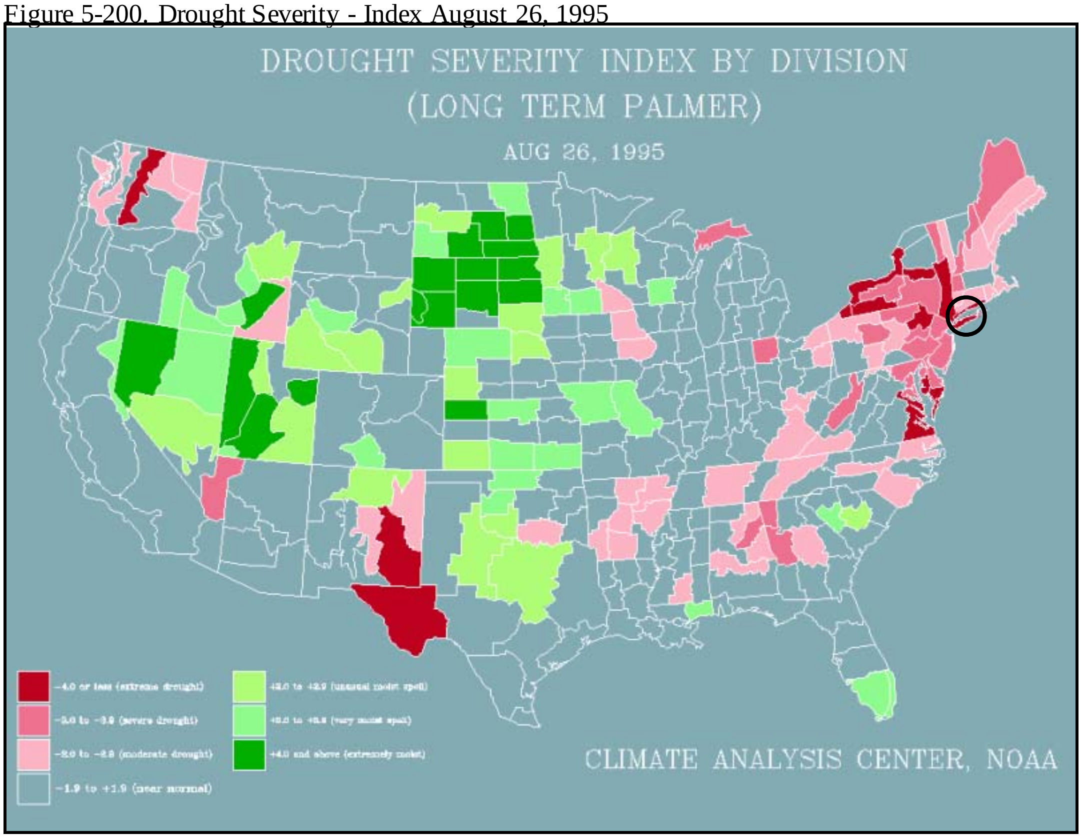
Source: Buxten and Smolensky, 2005

August - September 1995: Much of the Northeast and mid-Atlantic received little or no rain during this time period, exacerbating long-term dryness since mid-March 1995, and in some areas since October 1994. The severe short-term rainfall shortages enhanced a pattern of persistently subnormal precipitation dating back 6 to 11 months in much of the Northeast and mid-Atlantic. Most areas recorded less than 75% of normal precipitation, with localized sections of NY, lower New England, and the eastern mid- Atlantic observing under half of the normal precipitation. Typically, 16 to 23 inches of rain falls on the Northeast and eastern mid-Atlantic from March 12 to August 29, but only 10 to 15 inches was measured at most locations for the 171-day period in 1995. Rainfall was particularly short in eastern and southeastern NYS, northeastern Pennsylvania, and southern Vermont, where only 5 to 11 inches were reported. The long-term PSDI was rates as less than -4 ("extreme drought") over parts of central and southern NYS, southern

Connecticut, northeastern Pennsylvania, and the eastern mid-Atlantic on August 26, which included SC (Figure 5-200). All of southeastern NYS was placed under a drought watch by Governor Pataki's Drought Management Task Force.

The lack of rain on Long Island led to tinder dry conditions which aided the development of large wildfires, reportedly the worst in 60 years according to local officials. Two unusually large, severe wildfires, known as the "Rocky Point" and "Sunrise Fires", burned a total of 6,850 acres of the Central Pine Barrens over a 13 day period of this August - September 1995 drought. Forests were charred in Westhampton, Rocky Point, Calverton, and Medford, with a state of emergency in effect from August 24 until September 5, 1995. Burned areas included a portion of the globally rare dwarf pine plains. The wildfires were unusually severe and large because of extreme drought combined with increased winds and high fuel loads accumulated in the 65 years since the last major fire (Central Pine Barrens Wildfire Task Force, 1999). Nearly every fire department in Nassau and Suffolk Counties responded, along with several New York City departments and 32 federal, state, and local government agencies. Forty-nine firefighters were injured, none seriously. One house and five fire trucks were destroyed, and nine other houses plus the Westhampton train station were damaged (Blain, 1995). According to David Fischler, Commissioner of SC, (where the fires started) "weather was the dominant factor." According to Fischler, SC had a drought year (1995) consisting of 22 days with no rain and only 28 percent relative humidity, which is extremely low for SC. During this drought period, Mr. Fred Daniels, Deputy Commissioner of SC, indicated that in SC, during a summer day with drought conditions, it is not unusual to get many brush fires (Haftl, 1997). More information regarding this wildfire event is discussed earlier in this section (Section 5-4). Figure 5-200 shows a PDSI map of the U.S., including the study area.

Figure 5-200. Drought Severity - Index August 26, 1995



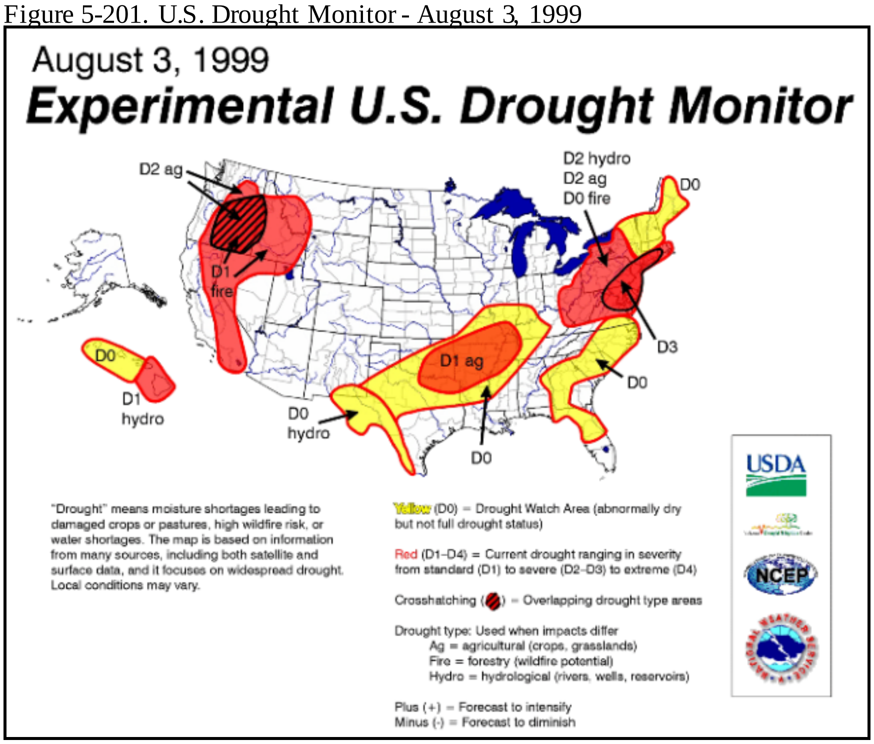
Source: NOAA, 1995

Note: The black circle within NYS indicates the approximate location of SC. SC is listed as having extreme drought.

July – August 1999: According to NRCC, the drought of 1999 was one of the most significant weather events for the northeastern United States. This drought culminated during the summer months and was perhaps the most costly weather event of that year. The dry conditions that prevailed during the second half of 1998 were a prelude to 1999's drought. Between the months of July and December 1998, the Northeast received only 71% of the normal precipitation, its third driest such period on record. After a wet January, the months of February through August 1999 followed a similar pattern, accumulating only 76% of the normal precipitation, resulting in the 3rd driest such period in 105 years of recorded data. Precipitation deficits for the fourteen months ending in August 1999 ranged from 6 to over 14 inches across the region. By mid-July, severe drought was reported in parts of every state in the Northeast Region. Extreme drought was noted in parts of Delaware, Pennsylvania, New Jersey, and NYS between late July and early September. Drought emergencies with mandatory water restrictions were declared in Maryland, Delaware, New Jersey and Pennsylvania. The Clinton Administration declared counties in nine states (Connecticut, Kentucky, Maryland, New Jersey, NY, Ohio, Pennsylvania, Virginia and West Virginia) as agricultural drought disaster areas. Abundant rainfall during September (twice normal and the wettest on record) brought an end to drought concerns (Eggleston, 1999). Throughout the drought region, farmers took the hardest economic blow. Recreation and tourism industries and natural areas also were hard hit (e.g., parks, gardens and golf courses). On Long Island, 140,000 acres of parks and nature preserves were off limits until the drought eased (Crary, 1999). Monetary losses were not documented in the materials available for review.

Mr. Michael Wyllie, a meteorologist with the NWS in Brookhaven, NY indicated that the drought in Long Island during this time period was one step below "extreme." The drought resulted in restrictions on water use, increased the danger of fire, and farmland disaster areas.

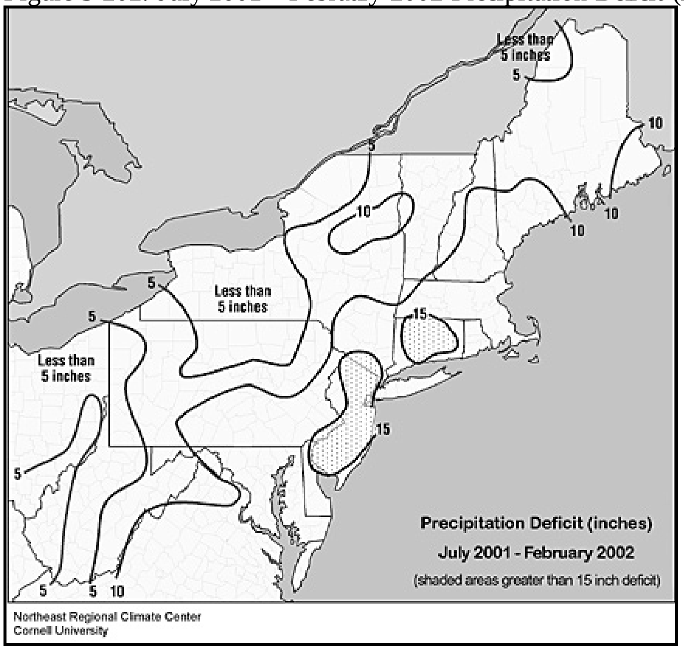
Figure 5-201. U.S. Drought Monitor - August 3, 1999



Source: Drought Monitor, 1999

July 2001 through March 2002: During this period, many coastal and large urban areas in the Northeast faced the worst precipitation deficits since official climatological record-keeping began more than a century ago. The most severe drought resulted in those communities experiencing at least a 15-inch precipitation deficit since July 2001 (including most of New Jersey, southeastern NYS, Connecticut, Rhode Island and Massachusetts). SC experienced a deficit of 10+ inches (Cornell, 2002).

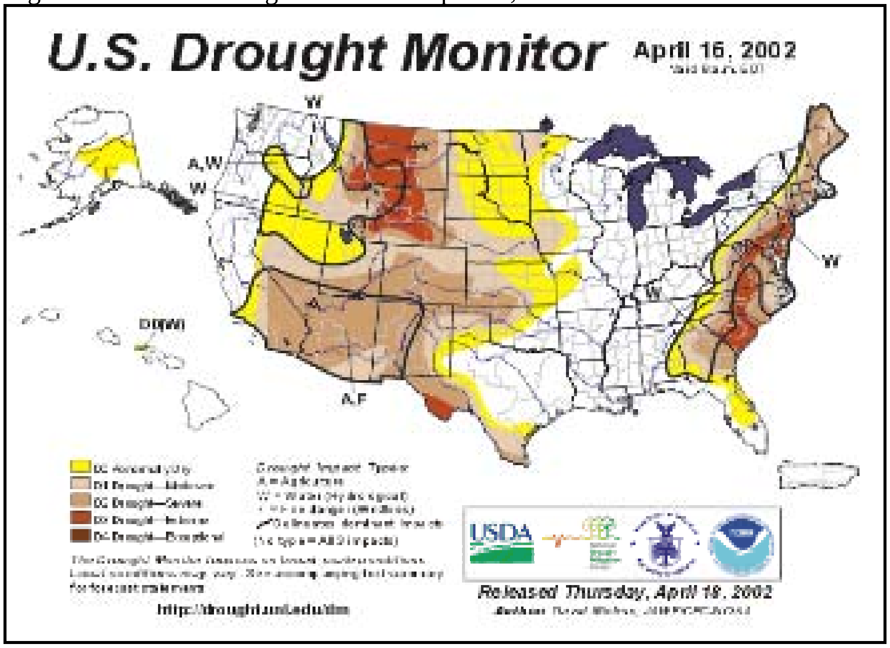
Figure 5-202. July 2001 – February 2002 Precipitation Deficit (in inches)



Source: Friedlander, 2002

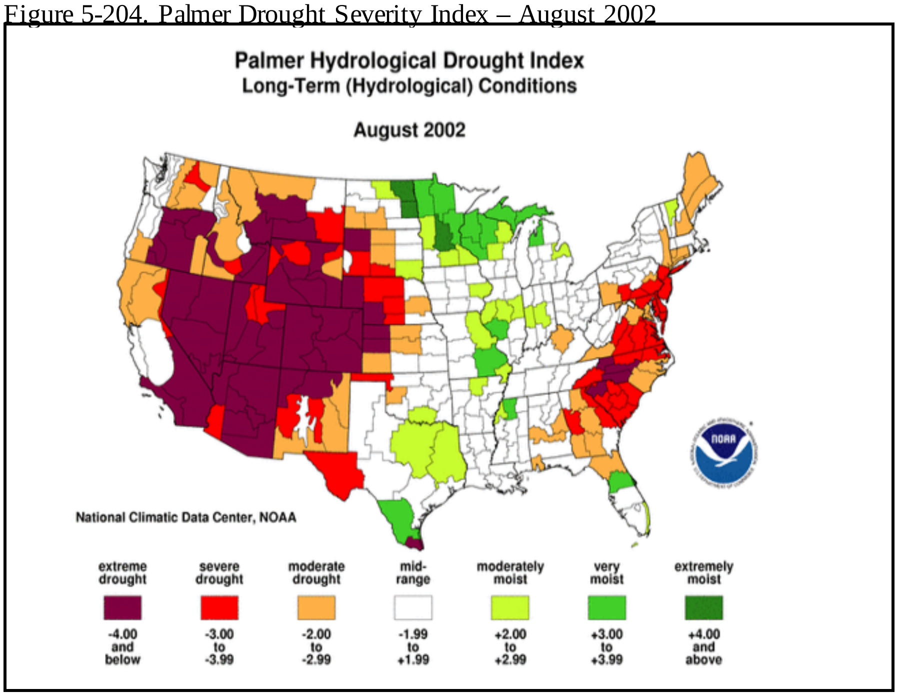
Drought of 2002: The 2002 drought, which affected the entire eastern seaboard and was identified as the worst in over 100 years, ended late in the fall of 2002. NOAA-NCDC indicated that NYS had the 26th driest July-September in the 108 year record in 2002. SC was issued a Drought Warning as of September 11, 2002. Ms. Jessica Chittenden of NYS Department of Agriculture and Markets indicated in November 2002, that 55 Counties (including SC) were eligible for drought assistance. All NYS agricultural counties were declared primary disaster areas by the USDA (Chittenden, 2002). Figures 5-203 and 5-204 show drought maps associated with this drought event.

Figure 5-203. U.S. Drought Monitor – April 16, 2002



Source: Miskus, 2002

Figure 5-204. Palmer Drought Severity Index – August 2002



Source: Heim, 2002

Probability of Future Events

Earlier in this section, the identified hazards of concern for the County were ranked. The NYS HMP includes a similar ranking process for hazards that affect the State. The probability of occurrence, or likelihood of the event, is one parameter used in this ranking process. Based on historical records and input from the Planning Committee, the probability of occurrence for drought events in the County is considered frequent [hazard event that occurs more frequently than once in 10 years ($>10^{-1}$/yr)] (see Table 5-3).

VULNERABILITY ASSESSMENT

To understand risk, a community must evaluate what assets are exposed or vulnerable in the identified hazard area. For the drought hazard, all of SC has been identified as the hazard area. Therefore, all assets in SC (population, structures, critical facilities and lifelines), as described in the County Profile section, are vulnerable to a drought. Assets at particular risk would include any open land or structures at located along the wildland/urban interface (WUI) that could become vulnerable to the wildfire hazard due to extended periods of low rain and high heat, usually associated with a drought. In addition, water supply resources could be impacted by extended periods of low rain. Finally, vulnerable populations could be particularly susceptible to the drought hazard and cascading impacts due to age, health conditions, and limited ability to mobilize to shelter, cooling and medical resources. The following text evaluates and estimates the potential impact of the drought hazard on SC including:

- Overview of vulnerability
- Data and methodology used for the evaluation
- Impact, including: (1) impact on life, safety and health of county residents, (2) general building stock, (3) critical facilities, and (4) economy
- Further data collections that will assist understanding of this hazard over time
- Overall vulnerability conclusion

Overview of Vulnerability

Essentially, all of SC is vulnerable to drought. However, areas at particular risk are: areas used for agricultural purposes (farms and cropland), open/forested land vulnerable to the wildfire hazard, areas where communities rely on private water supply, and certain areas where elderly, impoverished or otherwise vulnerable populations are located.

Potential drought impacts are agricultural, hydrologic and socioeconomic. Agricultural drought impacts are associated with soil moisture deficiencies relative to water demands of plant life/crops. Hydrological drought impacts are associated with the effects of insufficient precipitation (rain and snow) on surface and subsurface water supplies (e.g., reservoir and groundwater levels). Socioeconomic drought impacts are associated with the human health and business impacts that can occur when the demand for an economic good exceeds supply and shortages occur. For example, shortages in water supply can impact tourism due to high heat that make an area less desirable for recreation and deteriorate natural resources that are draws for tourists (NYS, 2004).

Data and Methodology

Data was collected from HAZUS-MH, USDA, NOAA NCDC, the County, and Planning Committee sources. At the time of this draft HMP, insufficient data are available to model the long-term potential impacts of a drought on the County. Over time additional data will be collected to allow better analysis for this hazard. Available information and a preliminary assessment are provided below.

Impact on Life, Health and Safety

Droughts conditions can cause a shortage of water for human consumption and reduce local fire-fighting capabilities. The drought hazard is a concern because both public and private water supply sources in SC are from local groundwater sources. As stated in the County Profile section, Long Island's groundwater system is a federally-designated "sole source" aquifer. Additionally, the area is also identified as a Primary Water Supply Aquifer by NYS Department of Health (1981) and NYS DEC (1987) (USEPA, 2007). The total capacity of the aquifers underlying SC is about 70 trillion gallons. Precipitation is the sole source of all naturally occurring fresh groundwater on Long Island. Seasonal- or long-term fluctuations in precipitation volume and, thus, in recharge, are reflected by the water levels in all aquifers.

According to the NYS HMP, groundwater and water storage facilities were below normal on Long Island during the November 2001 to January 2002 and April to October 2002 droughts. The dollar amount of damages associated with these droughts is documented as "unknown" (NYS, 2005).

The NYS HMP also lists mental and physical stress as social impacts of a drought (NYS, 2005). The infirm, young, and elderly are particularly susceptible to drought and extreme temperatures, sometimes associated with drought conditions, due to their age, health conditions and limited ability to mobilize to shelters, cooling and medical resources. For the purposes of this HMP, the entire population in the County is vulnerable to drought events.

Impact on General Building Stock and Critical Facilities

No structures are anticipated to be directly affected by a drought and are expected to be operational during a drought event. However, droughts contribute to conditions conducive to wildfires. The Central Pine Barrens is a forested area of approximately 102,500 acres within the central and eastern portions of SC; this area has an extensive history and ongoing risk of frequent wildfire (Central Pine Barren Wildfire Task Force, 1999). Risk to life and property is greatest in those areas where forested areas adjoin urbanized areas (high density residential, commercial and industrial) or WUI. Therefore, all assets in, and adjacent to, the WUI zone around the Central Pine Barrens, including population, structures, critical facilities, lifelines, and businesses are considered vulnerable to wildfire.

Impact on Economy

When a drought occurs, the agricultural industry is most at risk in terms of economic impact and damage. During droughts, crops do not mature leading to a lessened crop yield, wildlife and livestock are undernourished, land values decrease, and ultimately there is financial loss to the farmer (FEMA, 1997).

In 2003, there were 34,000 acres of farmland in SC, encompassing approximately six (6) percent of the County. The County ranks 27th in NYS for the number of farms and 50th for land in farms. According to the NY Agricultural Statistics Service, the average value of land and buildings per farm in 2002 was $920,960, with total production expenses being $176.4 million averaging $270,618 per farm. The United States Census indicates 63 percent of the farm operators report farming as their principal occupation

(USDA NASS, accessed online 2007). Table 5-65 shows the acreage of agricultural land exposed to the drought hazard.

Table 5-65. Agricultural Land in Suffolk County in 2002

Number of Farms	Land in Farms (acres)	Total Cropland (acres)	Permanent Pasture (acres)	Total Woodland (acres)	Other Land
645	34,000	26,616	921	1,849	4,614

Source: USDA NASS, accessed online 2007

In 2002, the market value of all agricultural products sold from SC farms was $201.2 million ($177.7 million in crop sales and $23.5 million in livestock), with total sales averaging $309,035 per farm (USDA NASS, Accessed online 2007). According to the SC Agricultural Protection Plan, the farm industry generates 8,000 jobs and adds another $214 million to the economy (Jones and Fedelem, 1996).

In 2002, the leading agricultural products sold were nursery and greenhouse plants (71%), vegetables (12%), poultry and eggs (7%), fruits and nuts (5%), aquaculture products (4%), and other products (1%). SC is ranked 1st in NYS for nursery and greenhouse stock and aquaculture products (USDA NASS, Accessed online 2007). Table 5-66 shows the square-footage of nursery and greenhouse stock in 2002.

Table 5-66. Nursery and Greenhouse Stock for Suffolk County in 2002

Bedding and Garden Plants*	Potted Flowering Plants*	Nursery Stock*
6,280,223	3,437,661	156,426

Source: USDA NASS, accessed online 2007
* Square-footage under glass or other protection

Additionally, Long Island's duck and equine industries generate $20 million and $1 billion annually, respectively for Long Island's economy. The Long Island Farm Bureau's internet site shows Long Island has the highest number of horses per capita in NYS and SC ranks 7th for equine inventory value in NYS (Long Island Farm Bureau, accessed online 2007).

SC's agriculture also provides the landscape and scenic beauty that supports Long Island's tourism industry. The Long Island tourism industry generates over $1 billion in revenues annually (Long Island Farm Bureau, accessed online 2007). SC wineries contribute to local tourism in the County. SC has the largest premium wine industry of any county in the U.S., with the exception of California. Long Island wineries encompass 1,600 acres of viniferous grapes and contribute $30 million annually to the economy (Long Island Farm Bureau, accessed online 2007). Historic data and current modeling tools are not available to estimate specific losses to tourism for the drought hazard.

The 2002 drought, identified as the worst in over 100 years, ended late in the fall of 2002. All NY agricultural counties, including SC, were declared primary disaster areas and eligible for drought assistance (Chittenden, 2002). Specific monetary losses for SC were not found in reviewed documentation.

If the average production (dollar value) per crop type could be identified on a per acre basis, loss estimates could be developed based on assumed percent damage that could result from a drought. If a drought impacted 40% of the agricultural products sold from SC farms, based on 2002 market values, this would be a loss of $80.48 million. This figure does not include how the tourism industry and local jobs are impacted.

A prolonged drought can have a serious economic impact on a community. Increased demand for water and electricity may result in shortages and a higher cost for these resources (FEMA, 2005; NYS, 2004). Industries that rely on water for business may be impacted the hardest (e.g., landscaping businesses). Even though most businesses will still be operational, they may be impacted aesthetically. These aesthetic impacts are most significant to the recreation and tourism industry. In addition, droughts in another area could impact the food supply/price of food for residents in the County.

Additional Data and Next Steps

For the revised plan, any additional information regarding localized concerns and past impacts will be collected and analyzed. This data will be developed to support future revisions to the plan. Mitigation efforts could include building on existing NYS, SC, and local efforts. The lead State Agency for drought preparedness is the NYS DEC.

Overall Vulnerability Assessment

Historic data available indicate that droughts can impact SC. Drought events can cause significant impacts and losses to the County's water supply and economy. The overall hazard ranking for SC determined by the Planning Committee for the drought hazard is "low" (Tables 5-6 and 5-7). The cascade effects of drought include increased susceptibility to the wildfire hazard, increased and thus shortages on local resources (i.e., water supply, electricity). Losses associated with the wildfire hazard are discussed earlier in this section.